

BROOKHAVEN NATIONAL LABORATORY NATIONAL SYNCHROTRON LIGHT SOURCE

MEMORANDUM

DATE: 30 June 2000

TO: Sam Krinsky, Michael Hart, Richard Osgood, Peter Paul

CC: NSLS Management Group, FEL Project Team

FROM: William S. Graves, Richard Heese, Erik D. Johnson

SUBJECT: DUV-FEL Project Report; Period ended 30 June 2000

Work in Progress:

Since our last progress report there has been a flurry of activity. A tremendous amount of effort went into improving our software tools for controlling the linac and monitoring parameters. Many small technical jobs described in the last progress report were completed in advance of the full week of running and studies between June 26 and today. In addition to our own team members, we had the benefit of two expert visitors this week to assist in the studies. Pat O'Shea from the University of Maryland came for a day to visit with Charles Neuman who is working on the COUR experiment as part of his thesis. David Dowell of Boeing has been working with machines like ours for over 20 years and was able to stay all week. Dave prepared the plots of charge versus laser power attached to the end of the report. The machine was run every day this week with extensive gun studies and a break on Thursday afternoon for another round of radiation survey fault studies. Bill and Dave will be summarizing the details of the measurements separately elsewhere. Although there were some hiccups (particularly with Klystron system A, see below) the system performed very well throughout the week.

Machine Studies: We have been continuing to study the behavior of the gun system. As previously noted the current required on the compensation solenoid is higher than anticipated to produce a small beam spot and the charge from the gun is lower than expected. The cathode surface was examined (as well as it can be without being removed) and it appears to have developed two defects (probably pits). Several separate experiments seem to indicate that the field at the cathode is substantially lower than it should be which may account for the large beam and the apparent early onset of space charge limited behavior of the gun. Further analysis of the data is under way to quantitatively compare the various measurements that all point qualitatively to the same result. We performed a cathode cleaning according to the current ATF procedure with no conclusive improvement in performance. When XiJie Wang returns from the EPAC we will consult with him on the best course of action for the cathode (replace or repair) and any other work that could be done to bring our gun system performance up to scratch.

Fault Studies: Bob Casey organized an effort to conduct a preliminary series of fault studies with Tom Dickinson, Marlon McAvoy and Rudy Zantopp. These were performed on Thursday afternoon with the goal of making sure we have instruments with adequate sensitivity to perform the real measurements. Comparisons of dark current only and photo-current beam in various intentionally created faults were measured and qualitative agreement with the models in the SAD analysis were obtained. In essence, neutrons dominate what is observed, and the patterns of loss seem to qualitatively match our expectations.

Analysis of the data is ongoing and will be used to guide the implementation of a 'real' fault study for the ARR team.

Work Planned for Next Week(s):

We will be down over the next several weeks for the installation of the COUR experiment (which is ready to go) and to address some of the issues described above. In particular it was noted that during system A faults, bubbles were observed to be rising from the tube socket (you can see them through the clear window on the side of the oil tank). So one service item is to drain the oil and drop the socket to try to find out what is happening and repair it if possible. Some inspection and service work will also be performed in modulator C to clean HV connections and replace cables as necessary. On the linac itself we will install a pickup on the tank 1 load, which requires briefly venting the linac. In the gun area we will vent the mirror cross and pull the mirrors to inspect them for damage. If/when we vent the gun, we will run a hall probe (from the mirror side) through the valve into the solenoid to confirm the field measurements made when the solenoid was on the bench (just to be sure). If a decision is made to work on the gun, that work will be performed before we return to running (if possible).

In broad terms the schedule is as follows;

July 5-7 Remove lead and modify stands to allow COUR installation, Tank 1 pickup, Check system A tube socket. BSA S&T visit July 7 PM

July 10-14 Vent transport line to install COUR magnet, new pop-in 10, linac survey, bake and re-install lead shielding

July 17-21 Contingency, gun work if necessary, recondition machine if possible

Management:

In addition to the issues noted above, one of our goals for the month of July will be completing required actions to obtain the recommendation of the ARR team for approval for routine operations.

Bonus Feature for the week:

The plots below are from this weeks measurements, and are a very careful series of measurements of charge as a function of laser power at two different spot sizes (The top plot is 1.5 mm diameter, the bottom plot is 1.0 mm Charge is in pC, laser power in micro-Joules). At low laser power the charge is linear with laser power and the slope of the solid line provides the quantum efficiency. The roll off in the charge at higher laser intensity is characteristic of space charge limited performance of the system, and as expected, the larger spot diameter rolls over at higher laser power and delivered charge. The curve is a fit using a model prediction published by Rosenswieg *et al*/several years ago (which is a surprisingly good fit to the data). As mentioned above, the comparatively early roll over into the space charge limited regime may be an indication of low field at the cathode surface.

